Ⅳ.　研究成果の刊行物・別刷

2 誤嚥

講義の到達目標

正常な嚥下のメカニズムについて理解し，誤嚥の病態を正しく説明することができる。
嚥下機能が低下する要因と誤嚥患者の嚥下機能評価について理解できる。
嚥下機能障害をきたした患者に対して，実習(研修)の担当患者ではどのような対処方法がなされていたのかを，主治医と治療方針について討議する。

はじめに

嚥下機能障害に伴う誤嚥により発症する肺炎を誤嚥性肺炎と呼ぶ。高齢者では知覚が低下することで不顕性に誤嚥を繰り返し，(誤嚥性)肺炎を発症することが問題となる。高齢者においては，食事摂取と関連した発熱や肺炎，脳血管障害に合併する日常生活動作(ADL)・全身状態の低下においては，積極的に誤嚥性肺炎の発症を疑い精査・加療を行う必要性がある。

加齢に伴いう歯や歯周病によって残存歯数は減少し，咀嚼機能が低下する傾向にある。嚥下反射の惹起性が低下することは，反射の開始が遅れ，嚥下反射運動の低下をきたすことで，その結果，安全な嚥下反射が保たれなくなり，咳嗽反射も低下する。

誤嚥の病態

誤嚥には，嚥下に関する組織・器官の構造に支障はないが，それらの動きが悪いために起こる機能的原因による障害(動的障害)と構造に異常がある器質的原因による障害(静的障害)に大別できる(表1)。

機能的原因としては仮性球麻痺(両側上位運動ニューロン障害)・球麻痺(延髄嚥下中枢障害)のような中枢神経系障害，および喉頭麻痺をきたす末梢神経障害，筋力の低下などで起こる。一方の器質的原因としては先天性奇形や腫瘍・外傷・術後などの後天的な構造異常があげられる。

また，誤嚥は嚥下前誤嚥・嚥下中誤嚥・嚥下後誤嚥のようにタイミングによって3つに分けられる。しかし，臨床的にはいつ，何を，どのくらいの頻度で誤嚥し，そのときに起こる反応など誤嚥に関与する因子を把握する必要がある。

嚥下機能評価

誤嚥の危険性，嚥下障害が疑われる高齢者は，①意識障害，②誤嚥性肺炎を繰り返し呼吸状態が

表1　高齢者の嚥下機能が低下する要因

器質的原因	
口腔・咽頭	歯牙喪失，口腔内乾燥，舌炎，口内炎，歯槽膿漏，扁桃周囲膿瘍，咽頭炎，頭頸部膿瘍，喉頭の下降
食道	食道炎，食道変形・狭窄，食道腫瘍，食道裂肛ヘルニア，頸椎の変形に伴う動きの不良
機能的原因	
咽頭	脳血管障害の潜在，既往疾患(脳血管障害，顔面神経麻痺，手術，頸部放射線治療)による影響，加齢に伴う変化
食道	食道アカラシア，膠原病(筋炎，強皮症，全身性エリテマトーデス)，胃食道逆流

表2　改訂水飲みテストの判定

評点	症状
1点	嚥下なし，むせる，または呼吸切迫を伴う
2点	嚥下あり，呼吸切迫を伴う(silent aspirationの疑い)
3点	嚥下あり，呼吸良好，むせ，または湿性嗄声を伴う
4点	嚥下あり，呼吸良好，むせない
5点	4点の症状に加え，追加嚥下運動(空嚥下)が30秒以内に2回可能

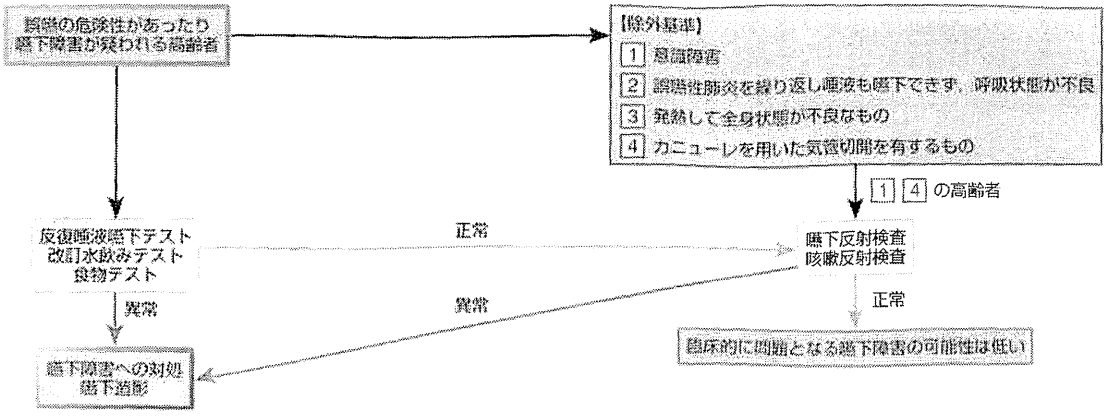

図1 嚥下機能評価と対処

不良，③発熱して全身状態が不良なもの，④カニューレを用いた気管切開を有するものを除外基準として，有用なスクリーニングとして反復唾液嚥下テスト，改訂水飲みテスト(表2)，食物テストなどがあげられる。不顕性誤嚥の評価法としては嚥下反射測定，咳嗽反射測定がある。さらに詳しい検査としては嚥下造影検査，嚥下内視鏡検査がある。

また，嚥下機能を評価後に，誤嚥がないことを確認した場合も，咀嚼嚥下動態に着目する必要がある。

スクリーニングにおいて異常が発見された場合は，できるかぎり嚥下造影を施行し，嚥下障害の種類を明らかにすることがその後の介入に有効である。悪性疾患などの明らかな原因疾患があり，かつ確定診断が得られ，専門治療が必要な場合を除いて上記の対処方法を試みるのが現実的である。

嚥下障害の対処方法

嚥下機能評価を行って嚥下機能の低下を認めた場合，誤嚥性肺炎のリスクがあると考え，原因検索とともに適切に対処する(図1)。

口腔ケア：加齢や疾患によりADLが低下することで，自己での口腔管理が不可能となった要介護高齢者，入院患者に対して行われる。具体的には義歯適合の確認，咽頭所見として下部脳神経機能障害の有無を確認する。また，気息性嗄声，湿性嗄声の存在にも注意し，スポンジやブラシなどを用いた衛生環境の改善を目指す。高齢者の口腔機能の維持・向上は老化・認知機能に関連することがわかっており，社会的に重要な課題である。

食事：嚥下訓練食の特徴は，①はっきりとした味で強めの香りを持ち，②温かい温度で，③ゼリーのきめが良好で，④崩れにくい食塊形成が容易な食品が望ましい。また嚥下機能によっては，とろみの使用も有効である。

体位：嚥下時はリクライニング位が有効である。食後も30度以上の座位を保つことが逆流防止に役立つ。

抗誤嚥薬の投与・内服薬の副作用：嚥下反射を改善する可能性のある薬剤として，ACE(アンジオテンシン変換酵素)阻害薬，アマンタジン，シロスタゾールなどが知られ，基礎疾患を考慮して使用する。また，副作用として，トランキライザー，消化性潰瘍薬・制吐薬，抗コリン薬などの内服により錐体外路系の副作用，唾液分泌低下をきたすことにも注意し，変更の必要性があれば主治医と相談する。

嚥下訓練：嚥下は嚥下運動により最も効果的な訓練が可能である。嚥下惹起促進目的に冷刺激を施行することや，嚥下呼吸協調性を強化し，安全性の高い嚥下様式を身につけるように指導する。

【入谷 敦・森本 茂人】

9 感覚器系

はじめに

加齢に伴い「目がみえにくい」「聞こえにくい」「においがわかりにくい」「苦みを強く感じる」など感覚器系に障害をきたし，生活の質(QOL)を低下させたまま生活を続けざるをえない高齢者は多数存在する。超高齢社会を迎え，高齢者はさまざまな問題を抱えていくことが予想される。老年医学から各専門科に対して，スムーズに連携できるように疾患概念を理解しておくことが望ましい。ここでは，加齢に伴い感覚器系が受ける障害について老年医学の立場から述べる。

視覚障害

40～50歳の間で遠方視力の低下が始まる。原因として，①角膜および水晶体の屈折力の変化，②網膜黄斑部の視細胞の受容能の減退(閾値の上昇)があげられる。老人性縮瞳も関与する。他に，後述するが白内障，加齢黄斑変性などによりさらに視力が低下する。静視力より動体視力の方が老化による低下が著しい。色視力・対比視力・夜間視力なども老化により低下する。

水晶体の硬化を主体とした器質的変化と，毛様体筋の生理的緊張の減少により，眼屈折度は正視の著明な減弱，遠視比率の著しい増加，平均値の遠視側への移動がみられる。一方，眼調節力が低下し老眼となる。調節力は遠視で最大に，近視で最小となるが，老人と成人で屈折状態の違いによる差は生じない。光があたってから瞳孔の縮小が開始するまでの対光反射時間，すなわち対光反射の潜時は老化とともに延長する。メカニズムについては反射弓の各要因の老化による機能低下が関与しうるが詳細な分析報告はなされていない。

日本における失明原因疾患としては緑内障，糖尿病網膜症，網膜色素変性症，加齢黄斑変性などが上位にあげられるが，これらの疾患は加齢に伴う疾患である。このほか白内障，網膜血管閉塞症なども高齢者においては重大な失明疾患である。眼組織ごとに加齢性変化をきたし，症状が出現する。成人眼疾患の各論は成書に譲り，ここでは緑内障，白内障，加齢黄斑変性についてまとめる。

緑内障

緑内障性視神経症と呼ばれる視神経に構造的・機能的異常をきたす疾患で，①原発開放隅角緑内障，②原発閉塞隅角緑内障，③続発緑内障，④発達緑内障に分類される。

原発開放隅角緑内障には眼圧が正常な正常眼圧緑内障が含まれ，診断には眼底所見(視神経乳頭陥凹拡大，網膜神経線維欠損)(図1)，眼圧，特徴的な視野異常が重要である。原発閉塞隅角緑内障

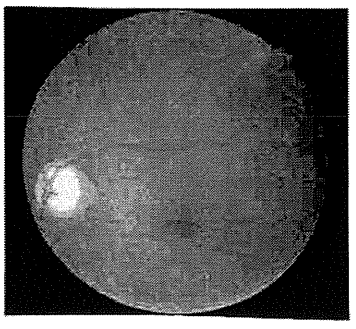

図1　原発開放隅角緑内障の眼底写真

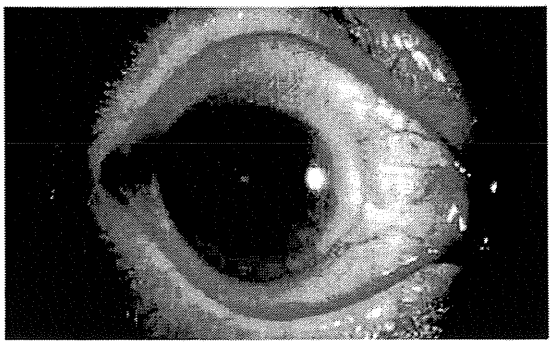

図2　急性緑内障発作
毛様充血が生じている

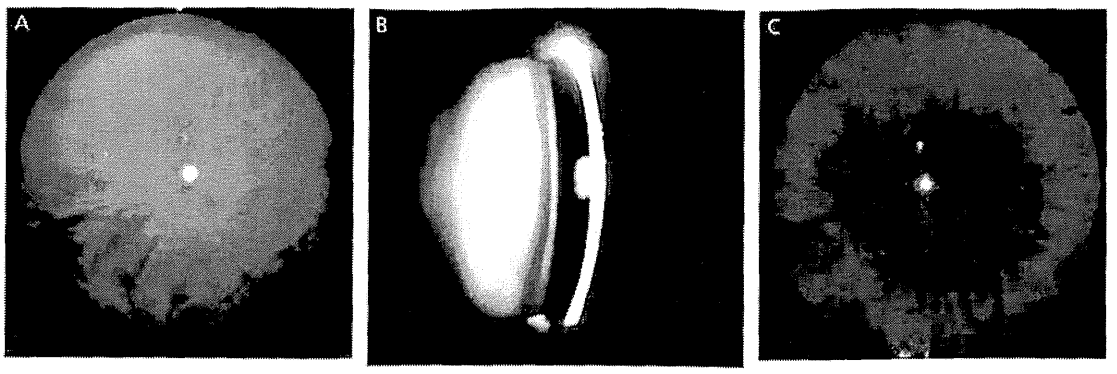

図3 白内障の細隙灯顕微鏡像
A：皮質白内障。B：核白内障。C：後嚢下白内障

では加齢に伴う水晶体の肥厚で浅前房，狭隅角を生じ，閉塞することで眼圧上昇をきたし，急激に隅角が閉塞し高度の眼圧上昇が生じるものを一般的に急性緑内障発作という。急性緑内障発作では毛様充血(図2)を生じるが，頭痛，嘔気・嘔吐などの症状も強いため眼科受診が遅れることがある。

緑内障性視神経症と頭蓋内腫瘍性病変で二次的に生じた視神経萎縮の鑑別は必ずしも容易ではなく，MRIや脳神経学的な検査が必要な場合もある。緑内障による視力・視野障害は回復することはないので，高眼圧，眼底所見などで緑内障が疑われる場合は早急な眼科へのコンサルトが必要である。

白内障

水晶体の混濁により視力低下をきたす疾患で，加齢が原因で生じることが多く，80歳以上の日本人では初期変化を含めるとほとんどの人が罹患する疾患である。紫外線，喫煙，ステロイド全身投与などが代表的な危険因子として知られている。皮質白内障，核白内障，後嚢下白内障が最も多くみられる混濁病型である(図3)。白内障の進行は緩徐なため，かなり進行するまで視力障害を自覚しない場合も多い。高齢者の場合，視覚からの情報・視性刺激遮断により認知症やうつ状態を悪化させる。また白内障による視力障害は転倒のリスクとして重要であり，骨折を生じると寝たきりになるなど著しくQOLの低下に影響を与える。

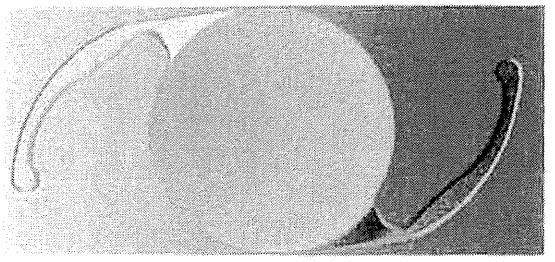

図4 多焦点眼内レンズ

白内障の診断は，散瞳後に細隙灯顕微鏡で水晶体を観察し，混濁病型および程度を評価し，手術適応の有無を判定する。初期症状は羞明(まぶしさ)，夜間視力低下，近見障害などが主症状であるが，進行すると単眼複視，高度の視力低下を生じ，最終的には失明に至る。抗白内障点眼薬やマルチビタミンが進行予防に有効であるが，視機能回復には手術以外有効な治療法はない。

近年は手術療法が進歩し，眼鏡なしで近くも遠くもみえる多焦点眼内レンズ(図4)などの多機能眼内レンズも登場し，視機能障害が軽度でもQOL改善の目的で手術を行うことが多くなっている。

加齢黄斑変性

萎縮型，滲出型の2種類に大別できるが，日本人は特に滲出型加齢黄斑変性が多く，50歳以上で100人に1人の割合で発症するとされている。

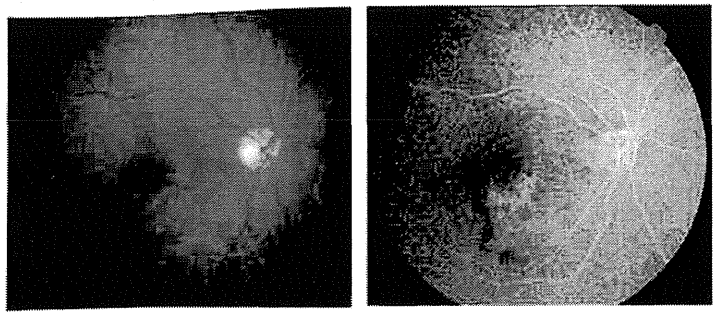

図5　加齢黄斑変性の眼底写真

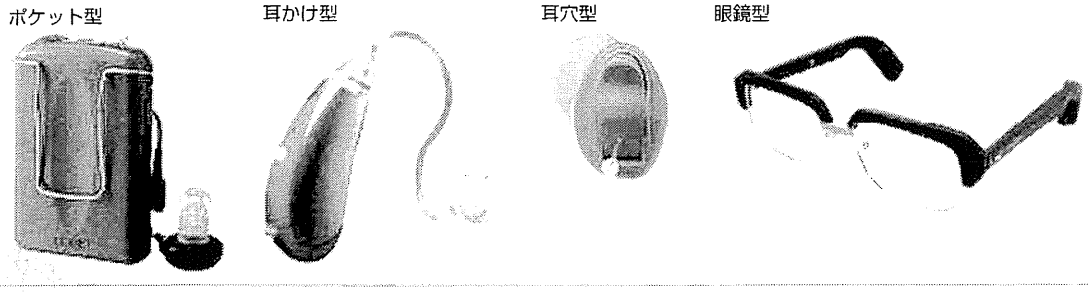

図6　補聴器

診断は眼底検査と蛍光眼底造影検査および光断層撮影で行う。初期病変としてドルーゼンがみられ，滲出型では黄斑部付近に脈絡膜新生血管を生じ，その部位から出血，滲出を生じる(図5)。初期症状としては「歪み」を自覚することが多く，進行すると中心暗点を生じ，最終的には不可逆的な中心視力障害をきたす疾患である。

近年，光線力学療法や抗VEGF(血管内皮増殖因子)抗体療法が滲出型の治療に有効であることが明らかになり，初期病変であれば視力改善が得られることが多い。「歪み」の段階で眼科専門医を受診することが失明に陥ることを防ぐ。萎縮型は有効な治療法はない。

聴覚障害

40歳を過ぎると聴力低下が高音域から徐々に始まり，50歳代では3,000Hz以上の周波数に著明な低下が現れる。さらに年齢が進むと，高音域での聴力低下が一層著明になるとともに，低音域の聴力低下も進行する。聴力損失の個人差も年齢が進むにつれて漸次大きくなり，高音域ほど著明であることが明らかである。

音は鼓膜を揺らし，それが耳小骨へと伝わり，蝸牛で電気信号に変えられ聴神経を伝わり脳に認識される。老人性難聴の原因は蝸牛の働きの衰えが多い。初期症状で耳鳴りを主訴とすることもあり，聴力の低下に加えて，言葉の聞き取りの低下を訴えることが多い。老人性難聴に対する有効な治療法はない。そのため，聴力を維持するために補聴器などの装着を指導し，周囲とのコミュニケーションを維持するように努める(図6)。コミュニケーション不足は脳機能低下を招き，精神・身体活動の低下を招くからである。

聴覚障害は，初期より周囲に認知されることが多いので，周囲が耳鼻咽喉科受診を勧め現状の聴力を評価し，さらに他疾患の合併を否定することが重要である。特に補聴器を使用する際には，難聴の程度，種類および外耳の形状により詳細な調

整が必要であるため，耳鼻咽喉科の診察を勧める。

味覚障害

老化により甘酸塩苦ともに閾値が上昇する。4つの基本感覚閾値の年齢変化は一様ではなく個人差が大きい。老化による機能低下の原因として有郭乳頭や葉状乳頭に存在する味蕾の数が減少する。乳頭の萎縮も起こるが，味覚に関する神経経路と中枢の老化に伴う機能低下も，味覚閾値上昇に関与していることが考えられる。

高齢者味覚障害は生理的な加齢性変化のみならず，全身疾患，治療のための薬剤投与，偏食による亜鉛摂取量の低下など，さまざまな要因が関連して引き起こされる。原因として亜鉛を含む栄養摂取不良，唾液分泌低下・口腔内乾燥，基礎疾患（糖尿病，腎障害，肝障害，消化器疾患など），服用薬剤，孤食などがあげられる。

おいしく食事摂取を続けるためには，カキ貝・ココア・豚レバー・抹茶のような亜鉛を多く含んだ食材[1),2)]の摂取，口腔内の消毒・義歯の管理を行うこと，全身疾患の管理，服用薬剤の注意（薬剤性もあるため），嗅覚・視覚・口腔知覚からも味わいの低下をきたすので五感を大事にすること，家族・友人と楽しく食事をとることなどに気をつけて，バランスのよい栄養補給，味わい楽しむ食生活を営むことが大事である（図7）。

嗅覚障害

老化とともに，形態的には嗅糸球と嗅神経の萎縮がみられ，鼻粘膜の感覚細胞の脱落が閾値の上昇の原因とされている。また，嗅覚に関与する神経経路の中枢の老化に伴う機能低下も嗅覚閾値上昇の大きな要因と考えられる。

嗅覚障害の原因で最も多いのは鼻副鼻腔炎で，全体の40～50%を占める。次いで感冒罹患後，外傷性と続くが，原因不明の嗅覚障害も20～30%

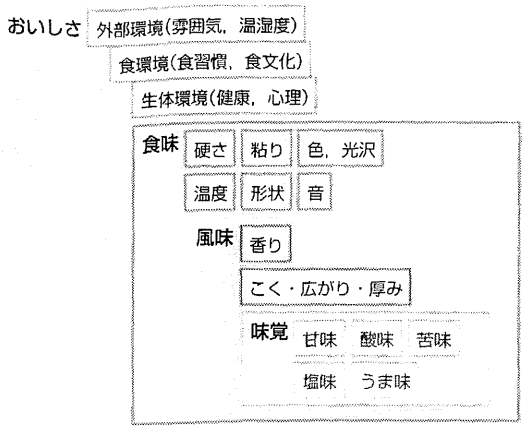

図7 味覚の成り立ち

を占め，そこには加齢性の嗅覚障害が含まれる。

男性では60歳代から，女性では70歳代から有意な嗅覚の低下を認め，喫煙が危険因子とされている[1)]。ただし原因不明あるいは加齢性と思われる患者のなかにも，副鼻腔炎による嗅覚障害症例が隠れていることがあり，耳鼻咽喉科専門医の診察が必要である。

治療は，急性・慢性副鼻腔炎やアレルギー性鼻炎などの鼻副鼻腔疾患が原因なら原因疾患の治療を行い，感冒後・薬剤性ならステロイド点鼻や薬剤変更を行う。頭部外傷や神経変性疾患など末梢神経・中枢神経性由来であれば治療困難である。

しかし，近年Alzheimer（アルツハイマー）型認知症，Parkinson（パーキンソン）病などの発症早期に嗅覚障害をきたすことが明らかになった。嗅覚障害を早期診断に活かすことで神経変性疾患の早期治療に役立てることが望まれる。

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FACTORS ASSOCIATED WITH DETERIORATION OF MINI NUTRITIONAL ASSESSMENT-SHORT FORM STATUS OF NURSING HOME RESIDENTS DURING A 2-YEAR PERIOD

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Abstract: *Objective:* A number of other studies have been conducted to verify the Mini Nutritional Assessment (MNA) or the MNA short form (MNA-SF) as a nutritional assessment/screening tool in various clinical settings or communities. However, there are few longitudinal studies using these tools to analyze which factors affect the incidence of deteriorating nutritional status. We tried to identify the factors associated with deterioration of MNA-SF status of nursing home residents during a 2-year period. *Methods:* Participants were 392 people with a mean age of 84.3 in 12 nursing homes in Japan. The factors associated with deterioration in MNA-SF categories during the study period compared to stable/improved MNA-SF categories were identified. *Results:* At baseline, 19.9% of the participants were malnourished and 60.2% were at risk of malnutrition, according to the MNA-SF classification. After 2 years, 66.3% participants maintained and 6.1% participants improved their nutritional status according to the MNA-SF classification, while 27.6% showed deterioration in MNA-SF status. Stepwise logistic-regression procedure indicated that basic ADL impairment and hospitalization during the follow-up period were associated with declining MNA-SF status. *Conclusions:* Poor basic ADL status and hospitalization during the follow-up period were associated with malnutrition and risk of malnutrition as assessed by MNA-SF of nursing homes residents during a 2-year period.

Key words: The factors associated with deterioration of Mini Nutritional Assessment-Short Form stage, frail elderly, nursing home.

Introduction

Japan has the most rapidly aging population in the world and soon will have the largest percentages of elderly and very elderly in its population. In 2011, the rate of the population over age sixty-five was 23.3%. Elderly persons 100 years or older numbered 47,756 and 87.1% of these were women. The numbers of frail elderly people living in the community or institutions for the aged are increasing, along with their hospital admissions.

The nutritional status of older people is an important determinant of quality of life, morbidity and mortality (1-3). The relationship between poor nutritional status and impaired immune functions, the development of pressure sores, and impaired muscle function is well established (4-6). Therefore, it is quite important for the elderly to maintain good nutritional status.

The Mini-Nutritional Assessment (MNA) is a simple clinical scale for the evaluation of the nutritional status of frail elderly subjects (4, 7, 8). We evaluated the MNA test as a screening tool for malnutrition in the Japanese elderly population and concluded that the MNA full test is a useful screening tool for identifying Japanese elderly with malnutrition or a risk of malnutrition (9). A number of other studies have been conducted to verify the MNA or the MNA short form (MNA-SF) as a nutritional assessment/screening tool in various clinical settings or communities. However, there are few longitudinal studies using these tools to analyze which factors affect the incidence of deteriorating nutritional status.

In the present prospective study we tried to identify the factors associated with deterioration of MNA-SF status of residents of nursing homes during a 2-year period.

Methods

Subjects

The study population consisted of 649 residents of 12 nursing homes located in Nagoya City (116 men and 533 women, age 65 years or older). Twelve nursing homes belonged to a single social welfare corporation and staffs of nursing homes received the same education training. The dietitians carry out the nutritional assessment of the nursing home residents according to the Long-Term Care Insurance (LTCI) program. These participants, who were enrolled between May 1 and June 30, 2009, were scheduled to undergo comprehensive assessments by trained nursing home staff at baseline, and at 12 and 24 months. At 3-month intervals, data were collected about any important events in the lives of the participants, including admission to the hospital, and mortality. Written informed consent for participation, according to procedures approved by the institutional review board of Nagoya University Graduate School of Medicine, was obtained from the residents or, for those with substantial cognitive

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impairment, from a surrogate (usually the closest relative or legal guardian).

Data collection

The data were collected at the nursing homes using structured interviews with residents and nursing home staff, and from nursing home records taken by trained nurses. The data included clients' demographic characteristics and a rating for ten basic Activities of Daily Living (ADL: getting out of bed, transferring, walking, bathing, grooming, dressing, putting on and taking off pants, feeding, bowel and bladder management). For each ADL task, nurses rated residents as independent (a score of 10, able to perform the activity without help), partially dependent (a score of 5, requiring some assistance), or completely dependent (a score of 0, needing help for the entire activity). The sum of these scores theoretically range from 0 (total disability) to 100 (no disability). Nurse ratings were based on direct observation, interviews with residents, and information from staff. Information obtained from nursing homes records included data on the following physician-diagnosed chronic conditions: ischemic heart disease, congestive heart failure, cerebrovascular disease, diabetes mellitus, dementia, cancer, neurodegenerative disorders including Parkinson's disease, and other diseases comprising the Charlson Comorbidity Index (10), which represents the sum of weighted indexes taking into account the number and seriousness of preexisting comorbid conditions. Chewing ability was categorized into three groups: difficulty chewing even soft food items such as boiled rice, tuna sashimi, and grilled eel (poor), difficulty chewing harder foods such as hard rice crackers, peanuts, and yellow pickled radish (fair), and no difficulty chewing harder foods (good). Dietitian ratings were based on direct observation and information from other staff.

Anthropometry

Height and weight data were generally measured at the nursing homes and collected by trained staff. Weight was measured in light clothing without shoes using a portable weight scale at the nursing homes. Height was generally measured in an upright position using a tape measure attached to the wall. However, when participants could not maintain an upright position, height measurements were obtained in a prone position.

Nutritional Assessment

The MNA-SF is composed of a combination of six questions taken from the full MNA about appetite loss, weight loss, mobility, stress/acute disease, dementia/depression, and body mass index (BMI). The score of the MNA-SF was used to classify subjects' nutritional status as well-nourished (a score of 12-14), at-risk for malnutrition (a score of 8-11), or malnourished (a score of 0-7). The MNA-SF was administered by dietitians, except for the mental state questionnaire which was obtained from nursing staff members or medical records at baseline, at 1 year later and at 2 years later.

Study participants

Among 450 survivors, the participants who stayed in the nursing home and were re-assessed at both baseline and at 2 years later were 392. The 60 participants who were assessed as malnourished according to the MNA-SF at both baseline and at 2 years later were excluded from our analysis to identify the factors associated with becoming malnourished or at risk of malnutrition.

Statistical analysis

The Student's t-test and Chi-squared test were used to compare differences between participants with the MNA-SF stage decline and those without decline (improved or stable MNA-SF stage). The 392 study participants were divided into tertiles according to the basic ADL score at baseline (first, 55-100; second, 20-50; third, 0-15). The significance level was set at $P< 0.05$ and quoted are two-sided.

Univariate and multivariate logistic regression models were used to identify independent predictors of declining MNA-SF status. The following baseline data were used in univariate analysis: gender, age, basic ADL, ability of chewing, and hospitalization during the 2-year period. The covariates included in the multivariate analysis were those variables associated with dependent variables at a level of $P< 0.05$ in univariate analysis. Stepwise logistic-regression procedure was conducted. The risk of a variable was expressed as an odds ratio (OR) with a corresponding 95% confidence interval (CI).

All analyses were performed using the Statistical Package for the Social Sciences (SPSS) Version 20.0. A probability value of 0.05 or less was considered significant.

Results

Among the 649 participants, 199 subjects died during the 2-year study period. It should be noted that mean MNA-SF score of 199 at the base line was significantly lower than that of 450 survivors (8.2 (SD 2.0) vs 9.3 (SD 2.4), $P<0.001$).

Table 1 shows the characteristics of the 392 participants at baseline. The mean age was 84.3 (SD 7.21) years, with 49.7% of the subjects 85 years or older and 82.9% of them women. The mean BMI, MNA-SF score and basic ADL score were 20.3 (SD 3.7) kg/m^2, 9.3 (SD 2.3) points, and 37.3 (SD 29.7) points, respectively. The participants had a high prevalence of dementia (56.9%), cerebrovascular disease (49.9%) and hypertension (46.4%). Among the 392 participants, 20.1% participants had poor chewing ability.

At baseline, 19.9% of the participants were malnourished and 60.2% were at risk of malnutrition, according to the MNA-SF classification (Table 1). As shown in table 2, after 2 years, 37.2% of the participants were classified as malnourished and 49.2% were at risk of malnutrition, according to the MNA-SF classification. Among the 392 participants, 260 (66.3%)

Table 1
Baseline characteristics of the 392 frail elderly

	total (n 392)			
	n	**% of total**	**mean**	**SD**
Age (years)	392		84,3	7,2
Body Mass Index (kg/m²)	392		20,3	3,7
MNA-SF score (max. 14 points)	392		9,3	2,3
MNA-SF classification				
malnourished	78	19,9		
at risk of malnutrition	236	60,2		
well-nourished	78	19,9		
Charlson comorbidity index (range, 0-19)	392		2,3	1,6
Chronic diseases				
dementia	223	56,9		
cerebrovascular disease	195	49,9		
hypertension	182	46,4		
heart failure	61	15,6		
ischemic heart disease	62	15,8		
diabetes mellitus	60	15,3		
Parkinson's disease	24	6,1		
Basic ADL (range, 0-100)	392		37,3	29,7
Chewing ability				
good	129	33,2		
fair	181	46,6		
poor	78	20,1		

Table 2
Mini Nutritional Assessment Short Form status at baseline and at 2-year follow-up

	MNA-SF status at 2-yr follow-up			
Baseline MNA-SF	**Malnourished**	**At risk of malnutriton**	**Well-nourished**	**Total**
Malnourished				
number of participants	60	18	0	78
% of baseline	76,9%	23,1%	0,0%	100,0%
% of at 2-year	41,1%	9,3%	0,0%	19,9%
At risk of malnutrition				
number of participants	77	153	6	236
% of baseline	32,6%	64,8%	2,5%	100,0%
% of at 2-year	52,7%	79,3%	11,3%	60,2%
Well-nourished				
number of participants	9	22	47	78
% of baseline	11,5%	28,2%	60,3%	100,0%
% of at 2-year	6,2%	11,4%	88,7%	19,9%
Total				
number of participants	146	193	53	392
% of baseline	37,2%	49,2%	13,5%	100,0%
% of at 2-year	100,0%	100,0%	100,0%	100,0%

participants maintained and 24 (6.1%) participants improved their nutritional status according to the MNA-SF classification (18 moved from "malnutrition" to "at risk of malnutrition"; 6 from "at risk" to "normal nutrition"), while 108 (27.6%) showed deterioration of MNA-SF categories during the study period (9 from normal nutrition to malnutrition, 22 from normal nutrition to at-risk status, and 77 from at-risk to malnutrition). Sixty (15.3%) participants were assessed as malnourished at both baseline and at 2 years later (Table 2). Therefore, the number of participants with improved/stable and deteriorating status according to MNA-SF classification, after excluding participants with malnutrition at both baseline and follow-up, were 224 and 108, respectively.

Table 3 compares the baseline characteristics of participants whose MNA-SF status deteriorated and remained stable/improved during the 2-year period. No differences were

Table 3

Baseline and 2-yr follow-up characteristics of participants with improved/stable or deteriorating MNA-SF status

	MNA-SF change during 2-year period								
	improved/stable status (n 224)				deteriorating status (n 108)				
	n	% of total	mean	SD	n	% of total	mean	SD	P value
Men/Women	50/174	22.3/77.7			11/97	10.2/89.8			0.007†
Age (years)	224		83,9	7,3	108		85,0	7,3	0.183*
Body Mass Index (kg/m2)	224		21,1	3,8	108		20,5	3,7	0.120*
Charlson Comorbidity Index	224		2,3	1,6	108		2,2	1,6	0.589*
Basic ADL (range, 0-100 points)	224		44,3	30,0	108		35,0	29,1	0.007*
first tertile (55-100points)	98	43,8			27	25,0			0.003†
second tertile (20-50points)	65	29,0			46	42,6			
third tertile (0-15 points)	61	27,2			35	32,4			
Chewing ability									
good	91	41,0			32	29,9			0.026†
fair	107	48,2			53	49,5			
poor	24	10,8			22	20,6			
MNA-SF score (max. 14 points)	224		10,0	2,0	108		9,8	1,9	0.523*
Hospitalization during the 2-year period	60	26,8			43	39,8			0.022†

* Student's t-test was used to compare differences between participants with the MNA-SF stage decline and those without decline; † Chi-square test was used to compare differences between participants with the MNA-SF stage decline and those without decline

Table 4

Stepwise logistic-regression procedure to identify independent predictors of deteriorating MNA-SF status

	crude			multivariate					
				model 1			model 2		
	OR*	95% CI	p	OR*	95% CI	p	OR*	95% CI	p
Women (vs men)	2,53	1,26 -5,10	0,009	2,54	1,25-5,17	0,010	2,41	1,18 -4,92	0,016
Age (continuous variable)	1,02	0,99 -1,06	0,183						
The score of basic ADL (range:0-100)									
first tertile (55-100points)	1,00			1,00			1,00		
second tertile (20-50points)	2,57	1,45 -4,54	0,001	2,60	1,46-4,63	0,001	2,62	1,47 - 4,69	0,001
third tertile (0-15 points)	2,08	1,15 -3,78	0,016	2,01	1,10 -3,68	0,024	2,02	1,10 -3,72	0,024
Chewing ability									
good	1,00								
fair	1,41	0,84 -2,37	0,197						
poor	2,61	1,29 -5,28	0,008						
Hospitalization during the 2-year period									
no	1,00						1,00		
yes	1,81	1,11 -2,94	0,017				1,80	1,09 -2,97	0,023

OR* Odds Ratio; P values ; logistic regression variables; model 1 using stepwise selection; adjusted includes gender, age,the score of ADL at baseline, and chewing ability at baseline; model 2 using stepwise selection; adjusted includes gender, age, the score of ADL at baseline, chewing ability at baseline, and hospitalization during the 2-year period

observed in age, Charlson Comorbidity Index score, BMI, or the MNA-SF score at baseline between participants in the two groups. The basic ADL score (range, 0-100) at baseline of the stable/improved MNA-SF group (44.3, SD 30.0) was significantly higher than that of the deteriorating MNA-SF group (35.0, SD 29.1) (P = 0.007). The prevalence rates of hospitalization during the 2-year period were significantly higher for those with decline in MNA-SF status (39.8%) than for those with improved/stable MNA-SF status (26.8%) (P = 0.022). There was also a significant difference in the chewing ability between two groups (P = 0.026).

To identify the factors associated with categorical decline of MNA-SF during the study compared to stable/improved MNA-SF status, stepwise logistic-regression procedure was

conducted. As shown in Table 4, women, lowest basic ADL status, poor chewing ability, and hospitalization during the 2-year period were independent predictors of a decline in MNA-SF status in univariate analysis.

We used two different models to conduct multivariate analysis, in which the variables with $P < 0.05$ in univariate analysis were further examined. In model 1 the covariates included were gender, age, basic ADL status, and chewing ability. In model 2, hospitalization during the 2-year period was added in the analysis. Stepwise logistic- regression procedure indicated a lower and lowest basic ADL status in model 1, and a lower and lowest basic ADL status and hospitalization during the follow-up period in model 2 were associated with deteriorating MNA-SF status (OR 2.60, 95%CI 1.46, 4.63, OR 2.01, 95%CI 1.10, 3.68, OR 2.62, 95% CI 1.47, 4.69, OR 2.02, 95% CI 1.10, 3.72, OR 1.80, 95% CI 1.09, 2.97, respectively).

Discussion

The aim of the present study was to identify the factors associated with deterioration of MNA-SF status of nursing home residents during a 2-year period. We showed that 27.6% of subjects had deteriorating MNA-SF status during the 2-year period and that basic ADL impairment and hospitalization experience during the study period were associated with this decline. Severity of comorbidity was not related with deteriorating MNA-SF status in this study.

At the baseline of this study, 19.9% and 60.2% of the participants were categorized by MNA-SF as malnourished and at risk of malnutrition, respectively. One review article has summarized the 13 studies in which MNA has been used for nutritional assessment in nursing homes, and reported that malnutrition was observed in 2 to 38% and a risk of malnutrition in 37 to 62% of nursing home residents (11). The combined database providing information on 1586 nursing home residents from 7 countries demonstrated that 32.9%, 53.4%, and 13.8% of residents were well-nourished, at risk of malnutrition, and malnourished, respectively (12). Recent study in which MNA has been used for nutritional assessment in 286 nursing home residents reported, malnourished (18.2%)and at risk of malnutrition (42.0%) (13). There have been only few studies to assess nutritional status of nursing home residents using MNA-SF. One study reported that 39.9% nursing home residents were assessed as well-nourished, 41.9% at risk of malnutrition, and 18.1% malnourished (14). In another study reported 66% of the screened by MNA-SF individuals were at risk of malnutrition and the prevalence of malnutrition is higher in women, in nursing homes and in older age groups (15). From these observations the prevalence rates of malnutrition classified through MNA/MNA-SF vary among various nursing homes. Compared with previous observations from nursing homes, fewer malnourished residents and more at risk of malnutrition were observed in the present cohort.

Most of the prospective studies using MNA/MNA-SF have demonstrated the predictive values of these nutritional screening tools for mortality or functional decline in various geriatric settings (16-18). However, there was no prospective studies to identify the risk of deterioration of MNA/MNA-SF status during a follow-up period. In the present study, we demonstrated that 3 variables at baseline—female gender, basic ADL impairment, and hospitalization—were associated with deterioration in MNA-SF status during a 2-year period. We do not know why women were associated with nutritional decline compared with men. Although women in nursing homes are on average older than men, the association persisted even if when age was incorporated in the analysis. It is possible that unmeasured factors might mediate this gender difference.

The odds ratio of dereriorating MNA-SF scores for participants in the third tertile (worst function) was lower than those in the second tertile. In the present study, the participants of the third tertile contained lower levels of mobility including bed ridden situation. It was possible there were the lower total energy expenditure among participants with advanced dysfunction compared with those with mid dysfunction.

There have been a number of cross-sectional studies demonstrating an association between physical function impairment/ADL dependence and poor nutritional status as assessed by MNA/MNA-SF (19-21). Although these studies suggest that there is an interrelationship between the nutritional status of the elderly in various settings and reduced functional capacity (22-24), the exact causal relationships remain controversial. The prior studies demonstrated that weight loss predicts the development of disability in older people (22-24). However, it remains unknown whether physical function/ADL status may influence the development of malnutrition or risk of malnutrition (25). The present study clearly indicated that the lowest basic ADL status was associated with a decline in MNA-SF status. This association persisted after adjusting for gender, age, and hospitalization during study periods.

There have been several cross-sectional studies showing that chewing problems are associated with malnutrition (26-28). Again, these results did not reveal the causal relationships between chewing ability and poorer nutritional status in the older people. The present study showed that poor chewing ability at baseline was associated with declining MNA-SF status during the study period in the crude model, although the ability was not selected by stepwise regression procedure, indicating that more attention should be paid to the impact of oral health, which imposes dietary restrictions on older people with consequences for their nutritional status.

The present study showed that hospitalization during the 2-year period was associated with a decline in MNA-SF status. In consisted with the previous studies demonstrated an association between hospitalization and malnutrition (3,29). It should be noted that there is one item asking about the presence or absence of psychological stress or acute disease in the past 3 months in MNA-SF. This may influence the association.

The present study has several limitations. The subjects of the

present study were dependent elderly people who had chronic diseases and needed help in everyday life at the nursing home. The results of the present study cannot be transferred to community-dwelling independent elderly individuals. These findings may not be generalizable to other populations given that they may have been influenced by health practices and a variety of social and economic factors.

In conclusion, this study showed that poor basic ADL status and hospitalization of nursing home residents during a 2-year follow-up period were associated with malnutrition and risk of malnutrition as assessed by MNA-SF.

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ORIGINAL ARTICLE: EPIDEMIOLOGY, CLINICAL PRACTICE AND HEALTH

Accumulation of geriatric conditions is associated with poor nutritional status in dependent older people living in the community and in nursing homes

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Aim: To clarify the association between nutritional status and the prevalence of geriatric conditions in dependent older adults.

Methods: A cross-sectional observational study of dependent older adults aged 65years or older who were living either in the community (n = 511, mean age 81.2years) or in nursing homes (n = 587, mean age 85.2years) was carried out. Data included the participants' demographic characteristics, basic activities of daily living, Charlson Comorbidity Index and the prevalence of eight geriatric conditions (visual impairment, hearing impairment, falls, bladder control problems, cognitive impairment, impaired mobility, swallowing disturbance and loss of appetite). Nutritional status was assessed by the Mini Nutritional Assessment short form (MNA-SF).

Results: Of 1098 participants, 21.4% (n = 235) were categorized as "malnourished", according to the MNA-SF classification. Participants in the "malnourished" group had a greater number of geriatric conditions than those in the other two groups. A higher prevalence of all the geriatric conditions except for falls was detected in the group with poorer nutritional status. Multivariate logistic regression analysis showed that malnutrition was associated with the number of geriatric conditions, but not with that of comorbidities, even after controlling for confounders.

Conclusions: Malnutrition was confirmed to have significant associations with geriatric conditions in dependent older adults. **Geriatr Gerontol Int 2014; 14: 198–205.**

Keywords: dependent elderly people, geriatric conditions, nutritional status.

Introduction

In most affluent societies, the aged population is growing. Economic restraints have instituted changes in the care of elderly individuals. One consequence of the recent reduction in hospital beds and the shorter hospital stays in Japan, as well as in other countries, is that hospital care, such as long-term geriatric care, for many older adults is no longer being provided; instead, those who require such care are now residing in various forms of assisted housing in both the community and long-term care facilities.[1]

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Geriatric conditions are used to describe complex clinical conditions or signs that are common in frail older people and do not fit into specific diseases or syndrome categories. Such conditions are highly prevalent, multifactorial, and associated with multiple comorbidities and poor outcomes, such as increased disability and decreased quality of life (QOL).[2] Nutrition is an important factor in health and functional ability, and the impact of nutritional state on physical and psychological well-being is especially high in older people.[3] Furthermore, older people are more likely than younger adults to have an impaired nutritional status and to be at high risk for nutritional deficiency when they become ill. In fact, malnutrition is common in geriatric populations, especially in nursing homes or among community-dwelling dependent older adults.[4,5] Poor nutritional status is directly linked to the negative consequences of reduced health and QOL among older people. A

number of studies have shown relationships between nutritional impairment and morbidity, functional decline, and mortality in older people.[6–8] Nonetheless, few studies have examined the relationships between nutritional status and geriatric conditions among older people in various settings.

To answer these questions, in the present study we examined whether or not nutritional status might be associated with the accumulation of geriatric conditions or which conditions might be associated with poor nutritional status among dependent older people living in the community and in nursing homes.

Methods

Participants

The present study consisted of baseline data of the participants in two different prospective cohort studies. One was a multidisciplinary intervention care program trial of community-dwelling older adults (age 65years or older) who were eligible for Japanese long-term care insurance program, lived in Nagoya City, Japan, and were receiving various home care services from the Nagoya City Health Care Service Foundation for Older People, which has 16 visiting nursing stations associated with care-management centers (control $n = 511$, intervention $n = 601$, total participants $n = 1112$). The participants enrolled between 1 June 2009 and 30 November 2009 were scheduled to undergo comprehensive in-home assessments by trained nurses to constitute baseline data. Among those participants, participants allocated to an intervention group were enrolled in the present study, as the nutritional evaluation was carried out only in the intervention group at baseline. The second group was an observational prospective cohort based on the residents of 12 nursing homes ($n = 657$) located in Nagoya City, Japan. The participants were enrolled between 1 May 2009 and 30 June 2009.

In community-dwelling and nursing home cohorts, 90 and 70 participants were excluded, respectively, because of the lack of nutritional evaluation data. Thus, baseline data on 511 (male $n = 216$, female $n = 295$, mean age 81.2 ± 7.9 years [SD]) community-dwelling participants and 587 (male $n = 108$, female $n = 479$, mean age 85.1 ± 7.8 years [SD]) nursing home participants were used for the analysis.

Written informed consent for participation was obtained from all participants or, for those with substantial cognitive impairment, from a surrogate (usually the closest relative or legal guardian) according to the procedures approved by the institutional review board of Nagoya University Graduate School of Medicine.

Data collection

The data were collected by trained nurses at the participants' homes or nursing homes from standardized interviews with patients or surrogates and caregivers, and from the records of care-management centers or nursing homes. The data included participants' demographic characteristics and the Barthel Index, a rating for 10 basic activities of daily living (bADL; bathing, bladder function, bowel function, dressing, feeding, grooming, mobility, stairs, toilet use and transfers) using summary scores ranging from 0 (total disability) to 100 (no disability). Information on the number of drugs that participants were taking, and the following physician-diagnosed chronic conditions were also obtained from care-management center records and from nursing home medical records: ischemic heart disease, heart failure, chronic obstructive pulmonary disease, cerebrovascular disease, diabetes, dementia, cancer, hypertension and other diseases comprising the Charlson Comorbidity Index,[9] which represents a sum of weighted indexes taking into account the number and seriousness of pre-existing comorbid conditions (range 0–19, with a higher value indicating higher comorbidity). To obtain the greatest possible uniformity of data collection in different settings, the nurses were trained in the interviewing of participants and in the collection of data with standardized questionnaires.

Evaluation of nutritional status

In the present study, nutritional status was assessed at baseline by the Mini Nutritional Assessment short form (MNA-SF), one of the most valid and most frequently used nutritional screening tools for older persons.[10,11] MNA-SF consists of six items: food intake, weight loss, mobility, psychological stress or acute disease, neuropsychological problems and body mass index (BMI). The maximum score of MNA-SF is 14. A score equal to or less than 7 points is regarded as an indicator of malnutrition, 8–11 points indicate a risk for malnutrition and equal to or more than 12–14 points indicate that the person is well nourished.[12] We previously validated MNA and MNA-SF in Japanese older people.[13]

Definition of geriatric conditions

We defined geriatric conditions as collections of symptoms common in older adults, not necessarily associated with a specific disease, that increase in prevalence with age.[14,15] In the present study, we used the following eight symptoms as geriatric conditions: (i) vision impairment (poor eyesight or blindness despite use of corrective lenses); (ii) hearing impairment (poor hearing despite use of hearing aids); (iii) falls (at least one fall in the past 12 months); (iv) bladder control problems including not only urinary incontinence, but also catheterization, and

an inability to control urination alone; (v) cognitive impairment (dementia diagnosed by a physician or the presence of apparent cognitive impairment); (vi) impaired mobility (requiring person assistance to walk or an inability to walk); (vii) swallowing disturbance (presence of abnormal volitional cough, abnormal gag reflex, dysphonia, dysarthria, cough after swallowing and voice change after swallowing); and (viii) loss of appetite (self-reported loss or reduced intake not attributable to specific reasons). The presence of geriatric conditions was self-reported by the participants in the standardized interview carried out by the nurses; or, for those with substantial cognitive impairment, it was reported by a surrogate, caregiver or trained nurses. The accumulation of geriatric conditions was defined by the number of symptoms that a patient had among eight symptoms as described. For the analysis, we also used six of the eight symptoms; that is, we excluded "swallowing disturbance" and "loss of appetite", which are closely related to nutritional status. Low BMI or low bodyweight was frequently included in geriatric conditions. These two conditions were not used in the present study, as they are directly involved in nutritional status.

Statistical analysis

Continuous variables were described by the use of statistical characteristics (means, SD). Discrete variables were described as counts and percentages. Analysis of variance or the χ^2-test was used to determine the differences among the MNA-SF classifications. Pearson's linear correlation coefficient and partial rank correlation coefficients adjusted for age and sex were used to measure the relationships between the MNA-SF score and the accumulated number of geriatric conditions. A *P*-value of <0.05 was taken to define statistical significance. We used univariate and multivariable logistic regression to determine which variables, including the presence of geriatric conditions, predicted malnourished versus well-nourished status evaluated with MNA-SF. For the multivariable logistic regression analysis, two models were used. Model I included sex, age, living settings (community or nursing home), the number of geriatric conditions among eight or six symptoms, and chronic diseases, such as diabetes mellitus and hypertension, which were significantly associated with malnutrition in univariate analysis. Model II included sex, age, living settings (community or nursing home) and all of the geriatric conditions. SPSS 15.0 (SPSS, Chicago, IL, USA) statistical software was used to analyze the data.

Results

The baseline characteristics of a total of 1098 participants aged 65years or over were compared among MNA-SF categories (Table 1). According to the MNA-SF classification, 21.4% ($n = 235$), 54.3% ($n = 596$) and 24.3% ($n = 267$) were categorized as "malnourished", "at risk of malnutrition" and "well nourished", respectively. The distribution of classifications differed significantly between institutionalized and community-dwelling participants. Compared with community-dwelling participants, the institutionalized older people had a higher prevalence of malnutrition and a lower rate of good nutrition when compared among the three groups of participants with different nutritional status classified by MNA scores. Significant differences were also detected in age, sex, prevalence of artificial nutrition, and scores of bADL and Charlson comorbidity index. Regarding the prevalences of chronic diseases, only those of diabetes mellitus and hypertension were found to be different among the three groups. There was also a significant difference in the number of geriatric conditions among MNA-SF classifications (Table 2). Poorer nutritional status according to the MNA-SF classification increased the number of geriatric conditions. Accumulation was higher in the malnourished group than in the "at risk of malnourishment" (among eight symptoms, among six symptoms) and in the "well-nourished" group (among eight, among six). There were significant differences among classes with regard to the prevalence of all the individual components of geriatric conditions. A higher prevalence of all of the components except falls was found in the poorer nutritional status.

As shown in Table 3, a significant negative correlation was detected between the number of accumulated geriatric conditions and the MNA-SF score. These correlations persisted after adjusting for age and sex. Similar results were observed when the accumulation of geriatric conditions was based on a total of six rather than eight symptoms. These results showed that participants suffering poorer nutritional status were more likely to have geriatric conditions.

Logistic regression analyses were carried out to evaluate the associations of variables including geriatric conditions with malnourished status evaluated with MNA-SF (Table 4). Unadjusted univariate analysis suggested that women, older age, lower bADL score, nursing home residence, the use of artificial nutrition, the number of drugs which participants were taking, the number of accumulated geriatric conditions (among eight symptoms OR 2.62, 95% CI 2.22–3.10; among six OR 2.36, 95% CI 2.00–2.78) and the presence of all of the components of geriatric conditions were associated with malnourishment. However, no association was observed with the Charlson Comorbidity Index or with the presence of chronic diseases, except diabetes mellitus and hypertension. Participants with either of these two lifestyle-related diseases were less likely to be malnourished.

Table 1 Nursing homes and community: baseline characteristics of participants by Mini Nutritional Assessment

	MNA (0–7) Malnourished	MNA (8–11) At risk of malnutrition	MNA (12–14) Well nourished	*P*-value
Nursing homes, *n* (% of total)	151 (25.7)	337 (57.4)	99 (16.8)	
Community, *n* (% of total)	84 (16.2)	259 (50.5)	168 (33.3)	<0.001
Nursing homes and community, *n* (% of total)	235 (21.4)	596 (54.3)	267 (24.3)	
MNA-SF score, mean (SD): nursing home*	6.1 (1.2)	9.2 (1.11)	12.5 (0.68)	<0.001
MNA-SF score, mean (SD): community*	5.8 (1.5)	9.6 (1.1)	12.5 (0.7)	<0.001
MNA-SF score, mean (SD): nursing home and community*	6.0 (1.3)	9.4 (1.1)	12.5 (0.7)	<0.001
Age, mean (SD)*	84.6 years (8.2)	83.8 years (8.1)	81.0 years (7.5)	<0.001
Men, *n* (% of men/total)	60 (25.5)	163 (27.3)	101 (37.8)	0.002
Artificial nutrition (% of total)	30 (12.8)	30 (5.0)	2 (0.7)	<0.001
Mean basic ADL, range 0–100 (SD)*	25.3 (27.0)	46.5 (30.9)	71.2 (23.9)	<0.001
No. drugs, mean (SD)*	5.0 (3.1)	5.6 (3.4)	7.2 (3.9)	<0.001
Charlson Comorbidity Index, mean (SD)*	2.6 (1.8)	2.4 (1.6)	2.6 (1.8)	0.045
Chronic diseases, *n* (% of total)				
Ischemic heart disease	36 (15.3)	99 (16.6)	47 (17.6)	0.790
Congestive heart failure	44 (18.7)	97 (16.3)	51 (19.1)	0.512
COPD	28 (12.0)	55 (9.2)	33 (12.4)	0.283
Cerebrovascular disease	104 (44.4)	270 (45.5)	118 (44.2)	0.929
Diabetes mellitus	32 (13.6)	88 (14.8)	76 (28.5)	<0.001
Cancer	13 (5.5)	33 (5.5)	16 (6.0)	0.961
Hypertension	102 (43.4)	294 (49.3)	169 (63.3)	<0.001

*Analysis of variance; others were analyzed using the χ^2-test. ADL, activities of daily living; COPD, chronic obstructive pulmonary disease; MNA, Mini Nutritional Assessment.

Table 2 Nursing homes and community: baseline characteristics of participants by Mini Nutritional Assessment

	MNA (0–7) Malnourished	MNA (8–11) At risk of malnutrition	MNA (12–14) Well nourished	*P*-value
Nursing homes, *n* (% of total)	151 (25.7)	337 (57.4)	99 (16.8)	
Community, *n* (% of total)	84 (16.2)	259 (50.5)	168 (33.3)	<0.001
Nursing homes and community, *n* (% of total)	235 (21.4)	596 (54.3)	267 (24.3)	
No. geriatric conditions, mean (SD)†				
Among 8	4.7 (1.6)	3.5 (1.6)	2.3 (1.5)	<0.001
Among 6	3.6 (1.3)	2.9 (1.4)	2.1 (1.3)	<0.001
Geriatric conditions, *n* (% of total)				
Vision impairment	115 (49.8)	220 (37.5)	71 (26.7)	<0.001
Hearing impairment	123 (53.0)	250 (42.4)	89 (33.5)	<0.001
Falls	36 (15.4)	118 (19.9)	78 (29.2)	<0.001
Bladder control problem	205 (87.6)	415 (70.3)	105 (39.3)	<0.001
Cognitive impairment	161 (69.1)	326 (55.3)	96 (36.4)	<0.001
Mobility impairment	210 (89.7)	413 (69.4)	115 (43.1)	<0.001
Swallowing problem	138 (59.5)	213 (35.9)	52 (19.5)	<0.001
Appetite loss	123 (56.2)	148 (25.2)	21 (7.9)	<0.001

†Analysis of variance; others were analyzed using the χ^2-test. The geriatric conditions among eight included vision impairment, hearing impairment, falls, bladder control problem, cognitive impairment, mobility impairment, swallowing problem and appetite loss; among six included vision impairment, hearing impairment, falls, bladder control problem, cognitive impairment, and mobility impairment.

Table 3 Association of the accumulation of the geriatric conditions in participants from nursing homes and community with MNA-SF score

	No. geriatric conditions Among 8†		No. geriatric conditions Among 6‡	
	r	*P*	*r*	*P*
MNA-SF				
Unadjusted	−0.495	<0.001	−0.392	<0.001
Adjusted§	−0.473	<0.001	−0.364	<0.001

†The geriatric conditions among eight included vision impairment, hearing impairment, falls, bladder control problem, cognitive impairment, mobility impairment, swallowing problem and appetite loss; ‡among six included vision impairment, hearing impairment, falls, bladder control problem, cognitive impairment, and mobility impairment. §Adjusted by age and sex. MNA, Mini Nutritional Assessment.

In multivariate analysis, the number of accumulated geriatric conditions was associated with malnourishment (in model I OR 2.51, 95% CI 2.11–3.00). When the number of accumulated geriatric conditions was based on a total of six rather than eight, similar results were observed (in model I, OR 2.21, 95% CI 1.86–2.64). In model I, diabetes mellitus and hypertension were no longer associated with malnourishment. It should be noted that, in model I, the significant association between the number of accumulated geriatric conditions and malnourishment persisted when the bADL score was included in the analysis (among eight OR 1.74, 95% CI 1.40–2.10; among six OR 1.26, 95% CI 1.01–1.57). Although nursing home residents were associated with malnourishment, there was no longer an association when the bADL score was included in the analysis (OR 1.32, 95% CI 074–2.35). In model II, which used each geriatric condition component instead of the number of accumulated conditions, the presence of a bladder control problem, cognitive impairment, mobility impairment, swallowing problem and appetite loss were each associated with malnourishment. In model II, sex, age and nursing home residence were not associated with malnourishment.

Discussion

The present study showed that nursing home residents had a higher prevalence of malnutrition (25.7%) than those living in the community (16.2%). Furthermore, both 16.8% and 33.3% of the institutionalized and community-dwelling older people, respectively, were well nourished. A study of elderly Germans estimated that 36.7% and 85.7% of institutionalized and community-dwelling participants, respectively, were well nourished, based on MNA-SF for nutritional evaluation.[16] In a study of elderly Taiwanese, 26.5% and 80.1% of institutionalized and community-dwelling participants, respectively, were considered well nourished according to MNA-SF categories.[17] The lower prevalence of well-nourished community-dwelling older people in the present study seems attributable to the multiple medical problems and the functional limitations among our participants.

Those with poorer nutritional status were older, had lower bADL scores and were more likely to use artificial alimentation. Although we do not know the exact reasons for the relationships between artificial nutrition and poor nutritional status, it is possible that those patients receive insufficient nutrients or that those receiving artificial nutrition have a background of a heavy disease burden.

It has been reported that functional disability in older people is associated with inadequate diet and weight loss.[18,19] Huang *et al.* compared the nutritional status of their functionally dependent and independent elderly patients, and found poor nutritional status with lower daily caloric intake in the former group.[20] Consistently in the present study, participants with lower classified MNA-SF were associated with a lower bADL score. We observed that presence of diabetes mellitus or hypertension is negatively associated with malnutrition, although these associations disappeared after adjustment. The participants with these chronic diseases had higher BMI levels than those without disease (diabetes mellitus 21.8 ± 3.6 *vs* 20.1 ± 3.7, $P < 0.001$; hypertension 21.1 ± 3.9 *vs* 19.6 ± 3.5, $P < 0.001$), consistent with MNA-SF evaluation, suggesting the participants with diabetes mellitus or hypertension seem to have better nutritional status compared with those without these chronic diseases.

We clearly showed that, among dependent older people in nursing homes and in the community, those with poorer nutritional status had more geriatric conditions. In fact, an increase of one geriatric condition among eight or six symptoms showed 2.62 or 2.36 OR of the risk of malnutrition in univariate analyses. It should be emphasized that the association persisted

Table 4 Nursing homes and community: factors associated with malnutrition

	Univariate			Multivariate model I			Multivariate model II		
	OR	(95% CI)	*P*	OR	(95% CI)	*P*	OR	(95% CI)	*P*
Women (*vs* men)	1.78	1.22–2.62	0.003	0.93	0.54–1.61	0.796	0.80	0.43–1.50	0.491
Age (continuous)	1.06	1.04–1.09	<0.001	1.00	0.97–1.03	0.946	1.03	0.99–1.06	0.194
Basic ADL (continuous)	0.95	0.94–0.96	<0.001						
Nursing home (*vs* community)	3.17	2.20–4.57	<0.001	2.25	1.34–3.77	0.002	1.31	0.68–2.52	0.413
Artificial nutrition (% of total)	19.30	4.56–81.68	<0.001						
No. drugs	0.84	0.79–0.88	<0.001	0.90	0.84–0.97	0.006	0.90	0.83–0.98	0.016
No. geriatric conditions									
Among 8	2.62	2.22–3.10	<0.001	2.51	2.11–3.00	<0.001			
Among 6	2.36	2.00–2.78	<0.001	2.21	1.86–2.64	<0.001			
Vision impairment	2.72	1.87–1.87	<0.001				1.57	0.87–2.85	0.137
Hearing impairment	2.22	1.55–3.19	<0.001				0.93	0.51–1.70	0.805
Falls experiences	0.45	0.29–0.70	<0.001				0.58	0.29–1.15	0.119
Bladder control problem	10.96	6.92–17.36	<0.001				3.27	1.72–6.21	<0.001
Cognitive impairment	3.94	2.71–5.72	<0.001				2.50	1.40–4.45	0.002
Mobility impairment	11.62	7.14–18.91	<0.001				4.73	2.39–9.37	<0.001
Swallowing problem	6.01	4.03–8.96	<0.001				2.59	1.43–4.69	0.002
Appetite loss	15.07	8.97–25.33	<0.001				16.45	7.84–34.54	<0.001
Chronic diseases, presence (*vs* absence)									
Charlson Comorbidity Index	0.99	0.90–1.09	0.844						
Ischemic heart disease	0.84	0.52–1.35	0.479						
Congestive heart failure	1.00	0.64–1.56	0.992						
COPD	0.96	0.56–1.64	0.879						
Cerebrovascular disease	1.00	0.70–1.43	0.989						
Diabetes mellitus	0.39	0.25–0.62	<0.001	0.62	0.34–1.13	0.118			
Cancer	0.91	0.43–1.94	0.816						
Hypertension	0.45	0.31–0.64	<0.001	0.92	0.55–1.56	0.766			

The geriatric conditions among eight included vision impairment, hearing impairment, falls, bladder control problem, cognitive impairment, mobility impairment, swallowing problem and appetite loss; among six included vision impairment, hearing impairment, falls, bladder control problem, cognitive impairment, and mobility impairment. ADL, activities of daily living; COPD, chronic obstructive pulmonary disease.

even after controlling for sex, age, bADL, living settings and comorbidities. Recently in a cross-sectional hospital-based observational study, Saka *et al.* also reported that patients who were malnourished or at risk of malnourishment according to the MNA full version had more geriatric conditions.[21] Although they reported that those with low MNA scores had more chronic diseases, in the present study comorbidity was not positively associated with malnutrition. This inconsistency seems to be related to the different settings of the

surveys. Saka *et al.* investigated hospital-based older patients, but our participants lived in the community or in nursing homes and did not have active diseases. Thus, nutritional status is closely related to the accumulation of geriatric conditions, but not to comorbidities, at least in dependent elderly people without acute illness.

We also observed that malnutrition was associated with various components of geriatric conditions. In the crude model, the presence of each component, except for falls, was more likely to be classified as malnutrition. In contrast, participants who had fallen were less likely to be malnourished. We observed that the bADL score of those who experienced falls was lower than that of those who did not experience falls (63.6 ± 24.4 *vs* 47.3 ± 34.3, $P < 0.001$). This relationship between falls and malnutrition appeared through bADL status, as this association disappeared after adjusting for bADL status (OR 0.82, 95% CI 0.47–1.41). Participants with the poorest bADL status (severe physical limitation, such as typically confined to bed) are less likely to fall.[22] The poorest bADL status is associated with poorer nutritional status, as described earlier.

After demographic adjustments, the presence of a bladder control problem, cognitive impairment, mobility impairment, a swallowing problem and appetite loss were each significantly associated with malnutrition. The exact reasons for the association between bladder control problems and malnutrition remain unknown. It is well documented that being overweight is a risk factor for urinary incontinence.[23] However, in the present study of dependent older people, we found the opposite result. One reason for this discrepancy might be the definition of bladder control problems, which in the present study included not only urinary incontinence, but also catheterization and an inability to control urination. There are many risk factors common to the development of both a bladder control problem and malnutrition. These common factors include bADL status, depression and multiple medical conditions.[24,25] It is also true for mobility impairment, which is also associated with malnutrition.

Many of the studies investigating the relationships between cognition and nutritional status focus on nutritional deficiencies as a consequence of dementia or cognitive decline. For instance, cognitive decline might impair the ability or desire to eat.[26] Weight loss and changed eating behavior are recognized characteristics of the progressive dementing process, and uncontrolled weight loss is almost inevitable in the latter stages.[27]

We showed the associations between malnutrition according to the MNA-SF classification, and both the presence of a swallowing problem and appetite loss. The impairment of swallowing function can have devastating health implications. These include not only aspiration pneumonia, but also malnutrition and dehydration, as well as changes in health status, including an increased need for care provision, especially for older adults. In fact, a recent large cross-sectional survey of geriatric wards of hospitals showed that swallowing difficulties were strongly associated with malnutrition.[28,29] How appetite control changes with age remains to be elucidated, but a loss of appetite is frequently observed with aging; in a phenomenon called the "anorexia of aging", the physiological reductions in appetite and food intake accompany normal aging or occur as a consequence of various diseases. Appetite loss and subsequent reduced oral intake are followed of course by weight loss and nutritional impairment.[30] However, it should be noted that despite the exclusion of these conditions that are directly linked to reduced energy intake, the accumulation of geriatric conditions (six items) is associated with poor nutritional status in dependent elderly.

In the present study, 42.3% and 18.4% of the participants in the community and nursing homes were male, respectively. One of the reasons for this difference of the ratio of males and females might be due to the different average age of the participants. The participants from nursing homes were much older than those from the community. The male gender ratio tends to reduce as age increases, and among the elderly there is usually an excess of females.

The present study had several strengths, including the relatively large number of participants in different settings: nursing homes and the community. Our analyses took into account potential confounders including age, sex, bADL status and comorbidity.

The present study had potential limitations, however. Data obtained from multiple nurses through standardized interviews might be inaccurate, although to minimize discordance in data collection, nurses were trained in interviewing older participants and caregivers before the start of the study. The degree of cognitive impairment was not included in the analysis, as cognitive function was not evaluated by a specific screening instrument. There is no consensus on the definition of a geriatric condition or what conditions that category should include. In the present study, potential key conditions/diseases, such as dizziness, delirium or pressure sores, osteoporosis, gastroesophageal reflux disease, chronic kidney disease and dyslipidemia, were not included in the analysis. Although mood, such as depression, might influence nutritional status, depressive status was not evaluated in the present study. The study used cross-sectional analysis, and we cannot draw conclusions about cause and effect. Further research is required to examine geriatric conditions and their longitudinal associations with nutritional status.